NASA Facts

National Aeronautics and
Space Administration

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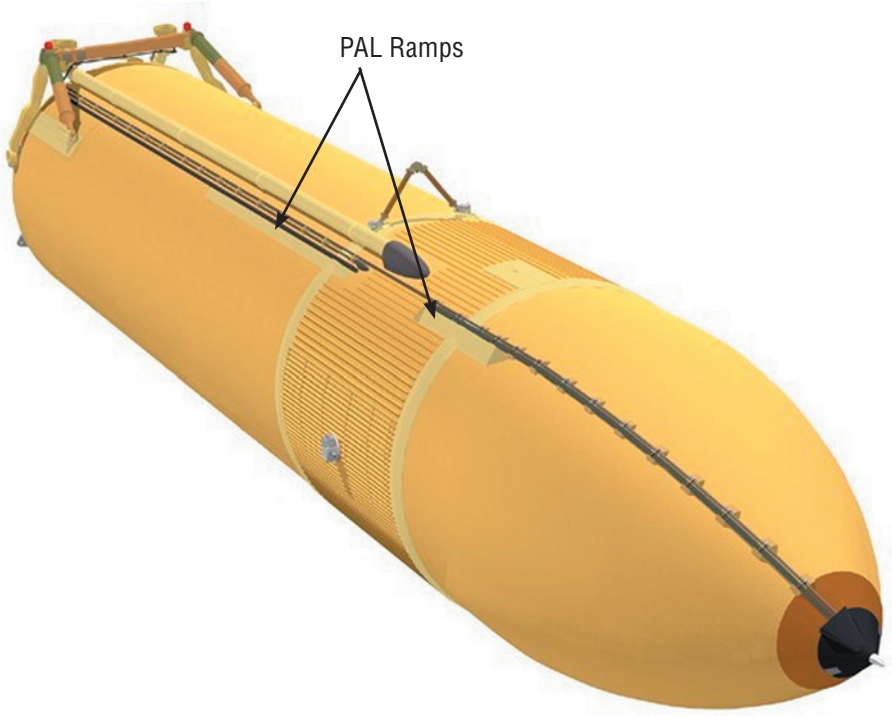
Return to Flight Focus Area

External Tank Protuberance Air Load (PAL) Ramps

Returning the Space Shuttle to flight is the first step in realizing the Vision for Space Exploration, which calls for a stepping stone strategy of human and robotic missions to achieve new exploration goals. NASA fuels discoveries that make the world smarter, healthier and safer. The Shuttle will be used to complete assembly of the International Space Station, a vital research platform for human endurance in space and a test bed for technologies and techniques that will enable longer journeys to the Moon, Mars and beyond.

To minimize the potential for debris loss from the External Tank, NASA has completed a top-to-bottom assessment of the tank's Thermal Protection System. As part of the assessment, the External Tank Project Office re-evaluated the existing design of the tank's protuberance air load ramps—known as PAL ramps—because the ramps, which consist of thick, manually sprayed layers of foam, could, if liberated, become a source of debris.

The PAL ramps are designed to protect the tank's cable trays and pressurization lines from airflow that could travel beneath the lines during ascent, inducing aerodynamic forces that could cause instability in the cable trays. One ramp is near the top of the liquid oxygen tank, close to the nose



Shown here is the liquid oxygen PAL ramp

cone; the other is below the intertank, near the top of the liquid hydrogen tank. The liquid oxygen PAL ramp is 13.7 feet long; the liquid hydrogen PAL ramp is 36.6 feet long.

Based on material analysis, testing and flight data, NASA is satisfied that the current design configuration of the PAL ramp is safe to fly and has approved plans to fly the next tank, ET 120, with that configuration. The forward 10 feet of the PAL ramp was removed on ET 120 to allow access to the tank's liquid oxygen/ intertank flange area and later replaced.

However, because of the size and location of the ramps and the possibility of debris from the area, NASA has established a team to develop alternatives to the current design that would satisfy the aerodynamic requirements. Extensive computational fluid dynamics analyses and wind tunnel testing has shown there is no evidence of aerodynamic instability on the cable trays during ascent. Therefore, the External Tank Project Office is considering eliminating the PAL ramps and is continuing to evaluate that possibility through a comprehensive testing and analysis program.

For more information, visit **http://www.nasa.gov**.

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